Branch Brook
Connecticut

Black Rock Lake Dam-Break Flood Analysis

SEPTEMBER 1983

US Army Corps
of Engineers
New England Division

BLACK ROCK LAKE
HOUSATONIC RIVER BASIN
CONNECTICUT

DAM-BREAK FLOOD ANALYSIS

BY
HYDROLOGIC ENGINEERING SECTION
WATER CONTROL BRANCH
ENGINEERING DIVISION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

SEPTEMBER 1983

DAM-BREAK FLOOD ANALYSIS
BLACK ROCK LAKE

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BLACK ROCK LAKE
DAM-BREAK FLOOD ANALYSIS

1. PURPOSE

This report presents the findings of a dam-break flood analysis performed for Black Rock Lake located in Thomaston, Connecticut on Branch Brook about 2 miles above the confluence of Branch Brook and the Naugatuck River and about 7 miles upstream of Waterbury, Connecticut.

Included are sections on pertinent features of the dam, the procedure used for the analysis, the assumed dam-break conditions, and effects of varying conditions (sensitivity tests) on the resulting downstream flood. This study was performed, not because of any known likelihood of a dam-break at Black Rock Lake, but rather to provide quantitative information for emergency planning use in accordance with Corps of Engineers regulation (ER 1130-2-419).

2. PROCEDURE

The Black Rock dam-break flood analysis was made using the "National Weather Service Dam-Break Flood Forecasting Computer Model", developed by D. L. Fread, Research Hydrologist, Office of Hydrology, National Weather Service, NOAA, Silver Spring, Maryland 20910. Input to the computer consisted of: (a) storage characteristics of the reservoir, (b) selected geometry and timing of the dam-break, and (c) hydraulic characteristics of the downstream river channel including tributary inflows, roughness coefficients, contraction-expansion losses, and active and inactive flow regions. Based on input data, the program first simulates a prebreach high flow steady state condition, and then computes the dam-break outflow hydrograph and routes it downstream. Calibration of the model is accomplished by comparing the assumed prebreach stage-discharge relationships with known stage-discharge relationships at various index stations along the river being modeled (i.e., at dams, gages, etc.). The dynamic unsteady flow routing is performed by a "honing" iterative process governed by the requirements of both the principle of the conservation of mass and the principle of the conservation of momentum. The analysis provides output on the attenuation of the flood hydrograph, resulting flood stages and timing of the flood as it progresses downstream.

3. DESCRIPTION

a. General. The study extended from the Black Rock Lake in Thomaston, Connecticut downstream along Branch Brook and the Naugatuck River to Beacon Falls, Connecticut, for a total distance of about 19 miles. The drainage area contributing to the study reach increases from 20.4 square miles at Black Rock Lake to 261 square miles at Beacon Falls. The major tributaries in the study reach are Hancock Brook, Steel Brook, Mad River and Hop Brook. There are six other Corps of Engineers flood control reservoirs in the Naugatuck River watershed above Beacon Falls, which are operated as a system principally to reduce flooding throughout the length of the Naugatuck River.

b. Black Rock Lake. Black Rock Lake is principally a flood control project with some water-based recreational activities, built and operated by the Corps of Engineers. Construction was initiated in November 1967 and completed in July 1971. Black Rock Lake is one of seven existing Corps reservoir projects operated to reduce downstream flood stages along the Naugatuck River. A map of the Housatonic River Basin is shown on plate 1. A map of the Naugatuck River watershed, with existing Corps projects indicated, is shown on plate 2.

The Black Rock Lake dam is a rolled earthfill embankment with an impervious core and rock slope protection. The dam has a curved embankment 933 feet long with a maximum height of 155 feet above the streambed. A photograph of the dam is shown on plate 3 and a general plan of the dam is shown on plate 4. The spillway is located in a rock cut along the right bank and is a low concrete ogee weir 140 feet in length with a crest elevation of 520 feet NGVD. The outlet works are located on the right bank and consist of an intake channel, a control tower on the upstream side of the dam, with twin 3' x 4' gates and a weir in front of one of the gates to maintain a permanent pool, a 704-foot long, 4-foot wide by 5-foot high rectangular conduit, and an outlet channel. A plan and profile of the outlet works is shown on plates 5 and 6. The lake contains a flood control storage capacity at spillway crest, of 8450 acre-feet, equivalent to 7.8 inches of runoff from the contributing 20.4 square miles of watershed. Pertinent data on Black Rock Lake is listed in table 1.

c. Downstream Valley. The river channel within the study reach downstream of Black Rock Lake, flows through five central Connecticut communities: Thomaston, Watertown, Waterbury, Naugatuck, and Beacon Falls in downstream order. Cross sectional data required for the model within this study reach was obtained from USGS topographical maps and flood plain mapping as well as available survey information.

Branch Brook is relatively steep, falling about 65 feet in about 2.3 miles from Black Rock Dam to the confluence with the Naugatuck River for an average gradient of about 28 feet per mile. The Naugatuck River has a lesser slope and falls uniformly about 195 feet in the 16.5 miles from the mouth of Branch Brook to the USGS gage in Beacon Falls for an average gradient of about 12 feet per mile. The flood plain reaches a maximum width of about 3500 feet upstream of Interstate Route 84 in Waterbury.

There are 27 bridge crossings over Branch Brook and the Naugatuck River within the study reach including three crossings of limited access type highways, three State highways, six railroads, and 15 local roads. In addition, there are 5 dams throughout the study reach. Hydraulic controls within the study area for the dam breach flood are described below. Principal tributaries in the study reach are Nibbling, Spruce, Hancock, Steel, and Hop Brooks, and Mad River.

(1) Connecticut State Route 8 Embankment. State Route 8 is a four-lane, limited access, interstate type highway that spans Branch Brook about 1.8 miles downstream of Black Rock Dam. The channel of Branch Brook in this area is about 30 feet wide with an invert of about 327 feet NGVD. The highway embankment slopes up uniformly on both sides of the brook at a rate of about 1 vertical to 2.5 horizontal. The low cord elevation is at about 381.5 feet NGVD and the top of road is between elevations 390 and 395 feet NGVD. This embankment would produce some hydraulic restriction during the dam breach flood.

TABLE 1

BLACK ROCK LAKE
PERTINENT DATA

LOCATION	Branch Brook, Thomaston and Watertown, Connecticut
DRAINAGE AREA	20.4 square miles
STORAGE USES	Flood control, recreation
RESERVOIR STORAGE	
Invert Elevation	410.0
Recreation Pool	437.0
Spillway Crest	520.0
Top of Dam	540.0
Flood Control Storage (net)	8450 acre-feet (7.8 inches)
EMBANKMENT	
Type	Rolled earthfill, rock slope protection, impervious core
Length	933 feet
Top Width	25 feet
Top Elevation	540 feet NGVD
Height	155 feet
SPILLWAY	
Location	Right-south abutment
Type	Uncontrolled ogee weir and chute spillway in rock
Crest Elevation	520 feet NGVD
Crest Length	140 feet
Surcharge	15 feet
Capacity	33,500 cfs
OUTLET WORKS	
Type	Rectangular concrete conduit
Size	4' x 5'
Length	704 feet
Gates	
Type	Hydraulic slide
Number	2
Size	3'0" x 4'0" high
Discharge capacity at spillway crest	900+ cfs
Downstream Channel capacity	800+ cfs

(2) Chase Brass Company Dam. This dam is owned by Chase Brass Company. It is located in the Watertown-Waterbury area and is approximately 5.9 miles downstream of Black Rock Dam on the Naugatuck River. It is a run-of-river type dam approximately 175 feet long and about 9 feet high. The spillway crest elevation is at 286.8 feet NGVD with 1 foot high flashboards to raise the crest elevation to 287.8 feet NGVD.

(3) Dam (7.8 miles downstream of Black Rock). This dam is located in Waterbury about 7.8 miles downstream of Black Rock Dam. From field investigations this dam appears to be a concrete ogee weir structure. It is a run-of-river dam about 8 feet high. The spillway has an approximate crest length of 320 feet at an elevation of 268 feet NGVD.

(4) Platt Bros. Dam. This dam is located in Waterbury about 12.4 miles downstream of Black Rock Dam. From field investigations it appears to be a concrete ogee weir structure about 9 feet high. The dam has a spillway length of about 220 feet at elevation 221.0 feet NGVD.

(5) Dam Downstream of Hop Brook. This dam is in the town of Naugatuck about 14.5 miles downstream of Black Rock Dam. It is a concrete structure less than 5 feet high. It has a spillway length of about 200 feet at elevation 184.4 feet NGVD.

(6) Dam Located Downstream of Route 63. This dam is also located in the town of Naugatuck about 15.3 miles downstream of Black Rock Dam. It is another low, less than 5 feet high, dam with a spillway length of about 180 feet at elevation 171.2 feet NGVD.

4. ASSUMED DAM-BREAK CONDITIONS

a. General. The magnitude of a flood resulting from a dam-break depends not only on the size of the project but also on the conditions of failure including the initial level of the reservoir, size of the breach, rate of breach formation, and hydraulic features and initial flows of the downstream river channel. The selected input parameters for the dam-break analysis at Black Rock Dam were considered the most severe that might be reasonably expected.

b. Selected Input Parameters - (Base Flood).

(1) Initial Pool Level - Full to spillway crest, elevation 520 feet NGVD.

(2) Reservoir Inflow - Actual August 1955 (flood of record) riverflow, 9,200 cfs.

(3) Breach Invert - Elevation 400 feet NGVD.

(4) Breach Base Width = 140 feet, trapezoidal side slopes: 1V:2H.

(5) Time to Complete Formation of Breach (Duration of Breach) - One hour.

(6) Prebreak Downstream Flow - August 1955 flood of record as modified by existing system of reservoirs.

(7) Downstream Channel Roughness - From Black Rock Dam to State Route 8 embankment - Manning's "n" = 0.08 to 0.10. Connecticut State Route 8 embankment to Beacon Falls - Manning's "n" = 0.03 to 0.08.

5. RESULTS

The resulting peak stage flood profile and flood delineations for the base flood are shown on plan and profile sheets 1 and 2 (reference plates 8 and 9). The adopted base flood was based upon the record August 1955 event. As the series of dams and reservoirs were constructed after the August 1955 flood, the riverflow was modified to include the effects of this regulation. Therefore, the computed prefailure profile is below that of the experienced August 1955 flood. Timing of the peak and leading edge of the flood wave are also indicated on the plan and profile plates. Development of the peak stage profile, discharges and stage hydrographs at three selected downstream stations (river miles 0.0, 9.36 and 18.77) are graphically illustrated on plate 10.

The dam-break discharge from Black Rock was 210,800 cfs and was attenuated to 152,100 cfs at the State Route 8 embankment.

In this 1.8 mile reach the State Route 8 embankment causes stages about 30 to 50 feet above normal river level thereby attenuating peak discharges.

Continuing from the highway embankment to Chase Brass Company dam, a distance of about 4 miles, the peak discharge would be attenuated from 152,100 cfs to 108,700 cfs and the resulting peak stage would be about 30 to 40 feet above normal river level.

Detailed studies were continued from the Chase Brass Company dam to Beacon Falls, a distance of about 13 miles, then concluded. In this reach the Naugatuck River flows over several small dams previously described. These dams do not have an appreciable effect on peak flood stages. Peak discharges would be further attenuated through this reach from 108,700 cfs to 82,200 cfs and peak stages would be about 15 to 30 feet above normal river level. At Beacon Falls, the peak flood stage would be approximately 15 feet above normal river level, or about 5 feet above the assumed prebreak high flow, and about 2 feet below the natural August 1955 floodflow.

The leading edge of the dam-break flood would reach Interstate Route 84 in Waterbury about 1.7 hours after the start of the failure and the resulting peak flood stage would occur approximately 2.6 hours after the start of the dam-break. Similarly, the leading edge of the dam-break would reach Beacon Falls about 3.2 hours after the start of the failure and the resulting peak flood stage would occur approximately 4.3 hours after the start of the dam-break.

The computer analysis was terminated at Beacon Falls. Peak stage of the flood wave at Beacon Falls would be about 2 feet below the peak stage of the record August 1955 flood.

6. SENSITIVITY TESTS

In addition to the analysis under the assumed dam-break conditions, subsequent studies were made to determine the sensitivity of certain selected parameters on the resulting downstream flood. Following are some of the variables considered:

a. Duration of Dam-Break. Though the selected duration for the failure time was 1 hour, runs were also made for failure times of both 3 and 5 hours. Changes in failure time resulted in stage reductions of up to 20 feet in the upper portions of the study reach and only minor reductions in the lower reaches. The relative effects of the three failure times on downstream flood profiles are illustrated on plate 11.

b. Breach Width . Runs were made with the initially adopted breach width of 140 feet and a comparative breach width of 360 feet. The 140-foot breach had assumed side slopes of 1 vertical to 2 horizontal while the 360-foot breach had side slopes of 2 vertical to 1 horizontal. There were only minor stage increases in the upper study reach and no increases further downstream. Comparative profiles for the two breach widths are shown on plate 11.

c. Initial Pool Level. An important factor in determining the magnitude of a dam-break flood is the level of the reservoir when the break occurs. Though a full reservoir condition was adopted, a run was made with the reservoir initially one-half full. Comparative downstream profiles are shown on plate 12 with the one-half full conditions. The resulting peak breach discharge at Black Rock was determined to be about 45 percent less than the adopted full pool conditions. The resulting peak flood levels were generally 10 to 5 feet less.

d. Channel Roughness. Manning's "n" sensitivity tests were made to determine their effect on downstream flood attenuation, resulting stages and timing. Tests were made with the Manning's "n" 20 percent greater. Increasing the channel roughness resulted in slower progression downstream with somewhat greater attenuation. However, the resulting variation in downstream flood profile was relatively small as illustrated on plate 12. The most significant effect of varying the channel roughness was the difference in timing of the peak flood stage. At Platt Brothers Dam in Waterbury, this timing varied from 3.0 to 3.4 hours for the base flood "n" values to the higher "n" values.

d. Downstream Dams. As noted previously, there are five dams on the Naugatuck River downstream of Black Rock Dam within the study reach. In the event of a major dam-break at Black Rock, under full pool conditions, these dams could be seriously damaged or fail. The adopted base flood condition assumed that all dams remain, however, the effects of possible failure were also considered.

In general, there is no significant storage behind any of the five dams. A failure of any of these dams would not cause a significant increase in flow and therefore probably would not cause a significant change in peak stage upstream or downstream of the structures.

The Chase Brass Company dam was selected for purposes of determining the effect of a secondary failure on ultimate upstream and downstream flood levels. This dam was selected over others principally due to its location, it is the first dam downstream of Black Rock.

For purpose of this test, Chase Brass Company dam was assumed to fail when the water surface reached elevation 300 or about 12 feet above the spillway crest, forming a trapezoidal breach with a 170-foot bottom width and 2V to 1H side slopes reaching a total top width of about 190 feet in 1 hour. The test revealed that the failure of Chase Brass Company dam would slightly reduce levels upstream and would have no influence on downstream stages, as illustrated on plate 13. Ultimate effects on both upstream and downstream levels are dependent upon the timing of the Chase Brass Company dam failure with respect to the Black Rock dam-break. In this test case, Chase Brass Company dam failed on the rising limb of the dam-break hydrograph from Black Rock. If Chase Brass Company dam failed coincident with the peak of the dam-break hydrograph from Black Rock, it is expected that downstream peak discharges and stages would be slightly increased.

f. Antecedent Riverflows. The base dam-break flood analysis assumed a high flow already occurring in the river at time of dam-break. This was considered appropriate since if a dam-break were to occur, it is quite conceivable that it would occur at a time of abnormally high flow conditions. The base flow conditions were selected as the recurring record August 1955 flood as modified by the presently existing system of Corps flood control reservoirs; namely Hall Meadow Brook Dam, East Branch Dam, Thomaston Dam, Northfield Brook Lake, Black Rock Lake, Hancock Brook Lake and Hop Brook Lake projects, which were all constructed following the August 1955 event.

The Black Rock outflow with the reservoir at spillway crest was 2500 cfs which would have been the approximate spillway discharge for the August 1955 flood. Progressing downstream, inflows to the study reach were as follows: 2000 cfs from the Naugatuck River, 4000 cfs from Nibbling Brook, 4000 cfs from Spruce Brook, 2000 cfs from Hancock Brook, 9000 cfs from Steel Brook and the Waterbury local, 4000 cfs from Mad River, 2000 cfs from Hop Brook and 8500 cfs from local tributaries. The resulting total pre-failure flow at Beacon Falls was 38,000 cfs.

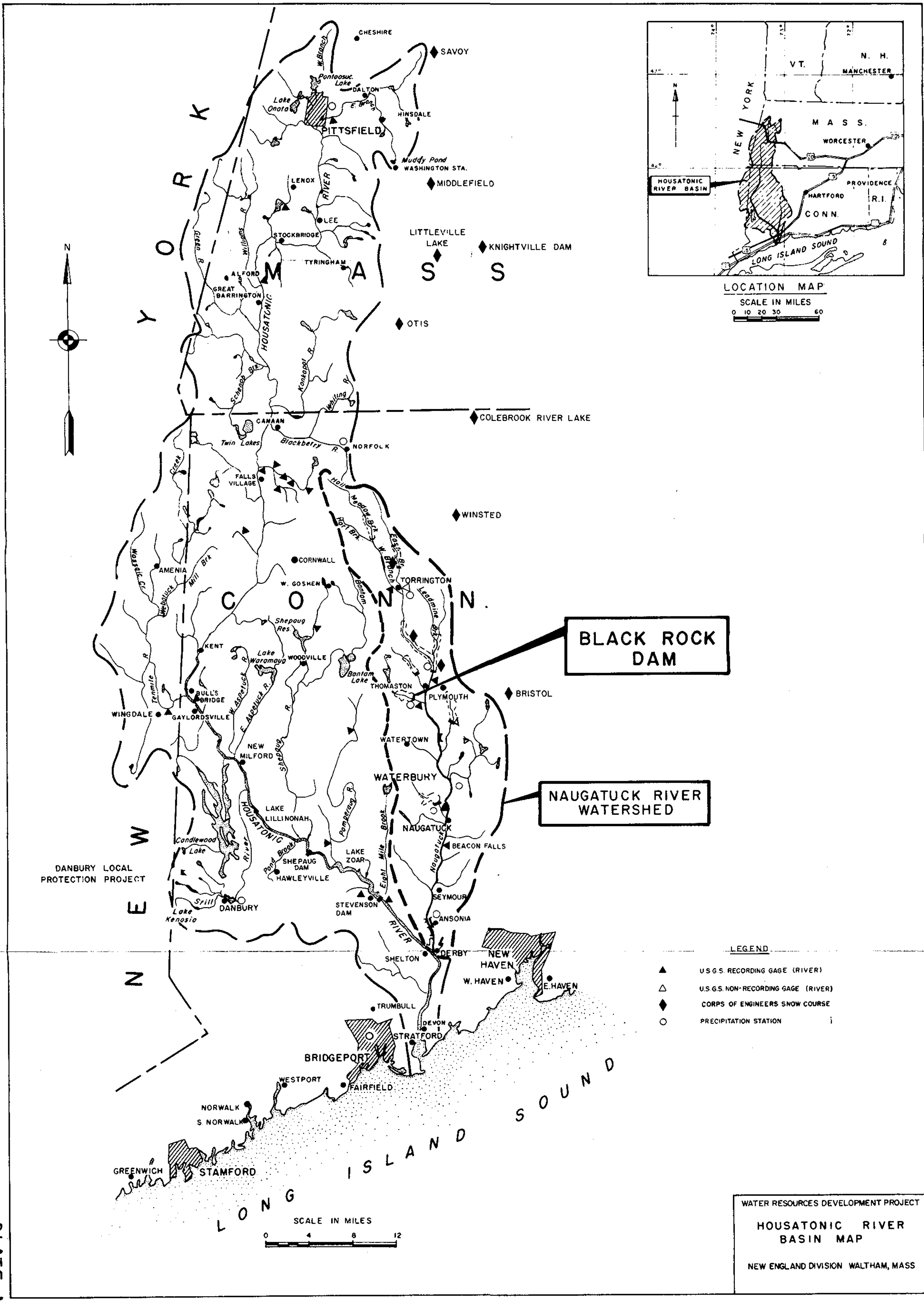
Therefore, the adopted antecedent flows and comparative experienced August 1955 discharges are as follows:

	Adopted Antecedent	Experienced August 1955
Black Rock Outflow	2,500	9,200
At Waterbury	23,500	90,000
At Beacon Falls Gage	38,000	106,000

An analysis was also made assuming a lower (50 percent of the base flood antecedent flow) antecedent riverflow at time of dam-break and comparative flood stages are illustrated on plate 13.

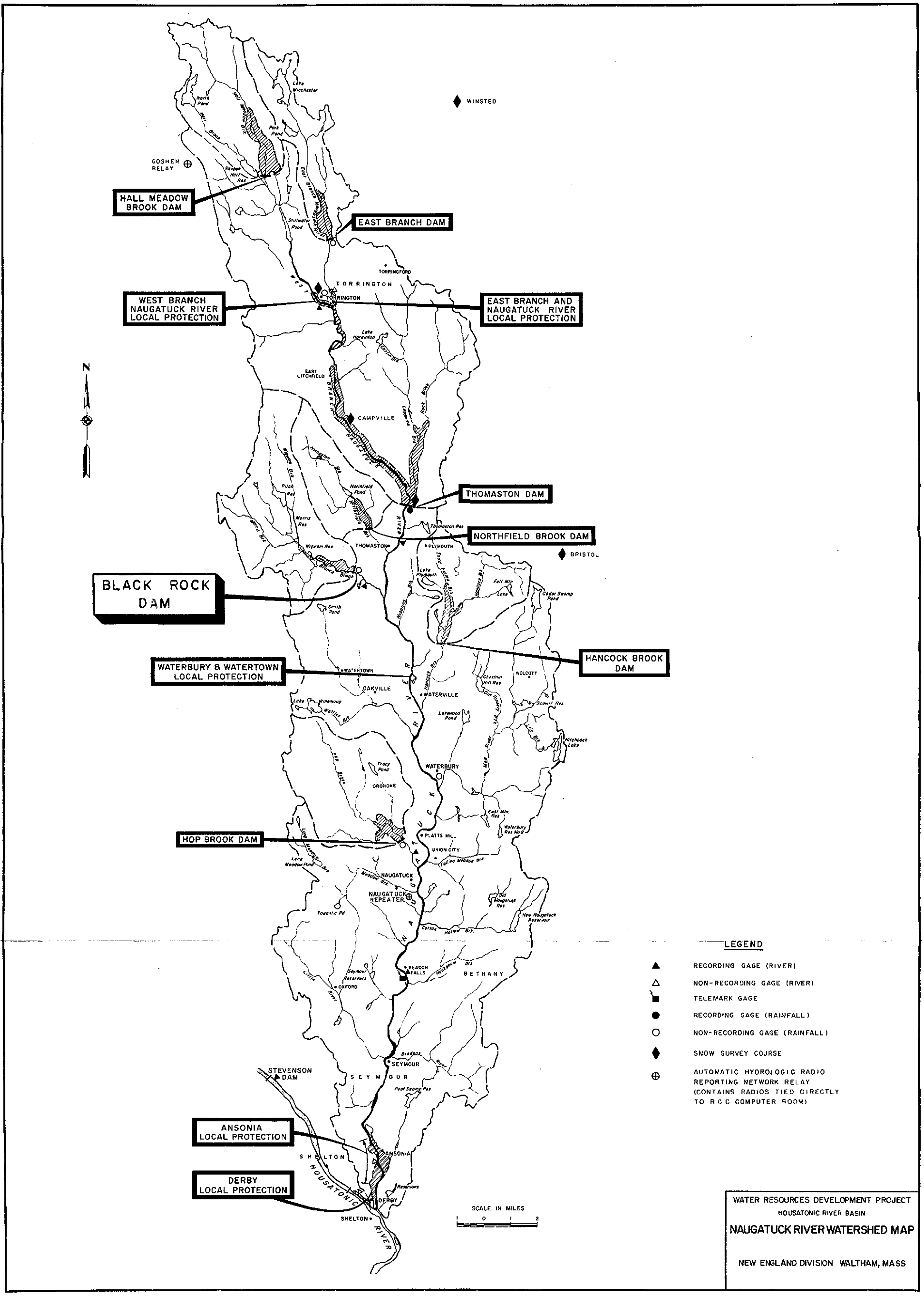
7. DISCUSSION

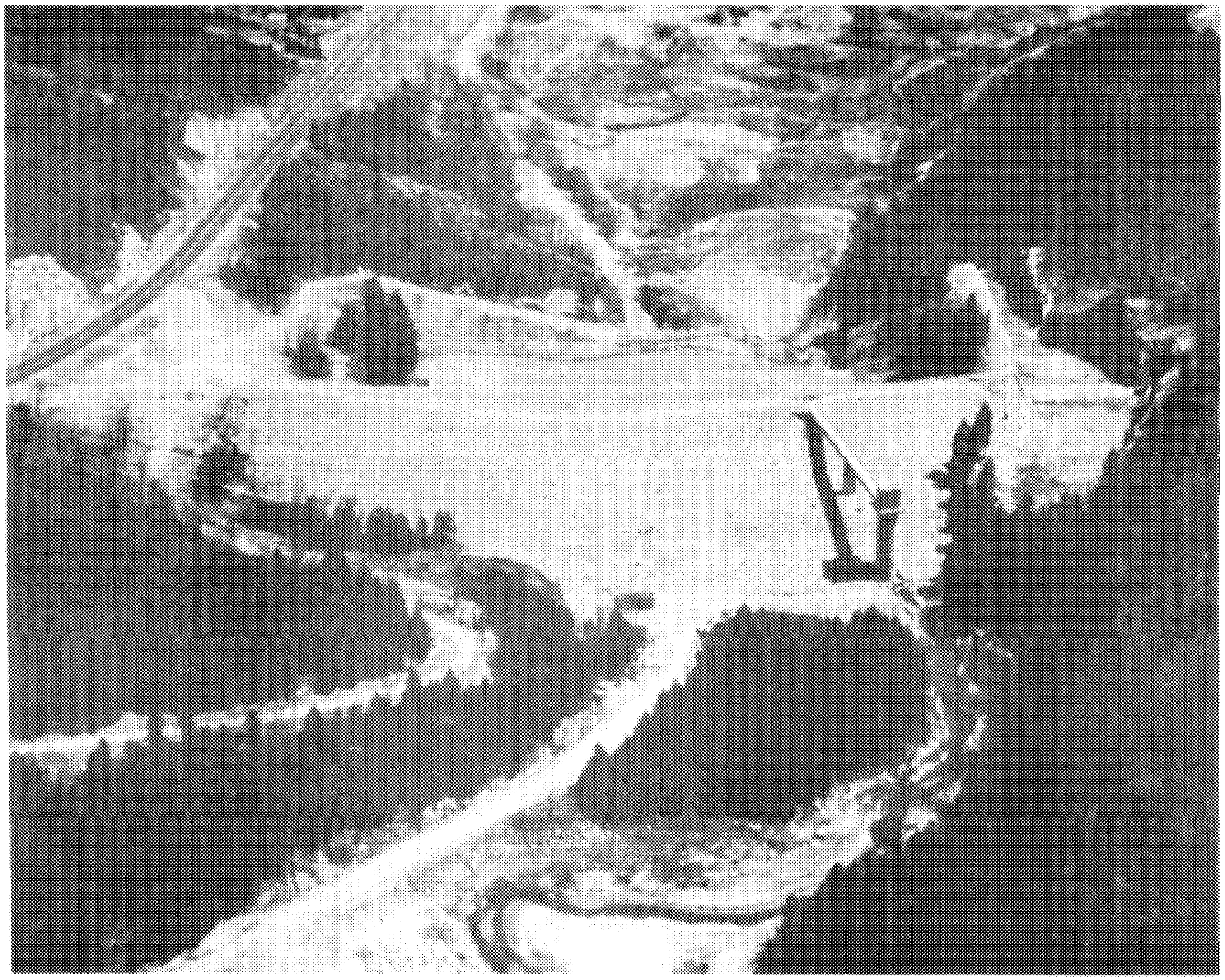
The dam-break analysis for Black Rock was based on the engineering application of certain laws of Physics, considering the physical characteristics of the project and downstream channel, and conditions of failure. Due to the highly unpredictable nature of a dam-break and the ensuing sequence of events, the results of this study should not be viewed as exact but only as an approximate quantification of the dam-break flood potential. For purposes of analysis, downstream conditions are assumed to remain constant and no allowance is made for possible enlargement or relocation of the river channel due to scour or the temporary damming effect of debris all of which could affect, to some extent, the resulting magnitude and timing of flooding downstream.



BLACK ROCK DAM
NAUGATUCK RIVER WATERSHED
DANBURY LOCAL PROTECTION PROJECT
LOCATION MAP
SCALE IN MILES
0 10 20 30 60
HOUSATONIC RIVER BASIN
VT.
N. H.
MANCHESTER
NEW YORK
MASS.
WORCESTER
PROVIDENCE
R.I.
HARTFORD
CONN.
LONG ISLAND SOUND
LEGEND
U.S.G.S. RECORDING GAGE (RIVER)
U.S.G.S. NON-RECORDING GAGE (RIVER)
CORPS OF ENGINEERS SNOW COURSE
PRECIPITATION STATION
NEW YORK
MASS
CONN.
LONG ISLAND SOUND
CHESHIRE
SAVOY
Pontoosuc Lake
DALTON
Lake Onota
PITTSFIELD
HINSDALE
Muddy Pond
WASHINGTON STA.
MIDDLEFIELD
LENOX
LEE
STOCKBRIDGE
LITTLEVILLE LAKE
KNIGHTVILLE DAM
TYRINGHAM
ALFORD
GREAT BARRINGTON
OTIS
HOUSATONIC
COLEBROOK RIVER LAKE
CANAAN
Twin Lakes
Blackberry R.
NORFOLK
FALLS VILLAGE
WINSTED
CORNWALL
AMENIA
W. GOSHEN
TORRINGTON
Shepaug Res.
Lake Waramaug
KENT
WOODVILLE
Bantam Lake
THOMASTON
PLYMOUTH
BRISTOL
BULL'S BRIDGE
WINGDALE
GAYLORDSVILLE
NEW MILFORD
WATERTOWN
WATERBURY
LAKE LILLINONAH
NAUGATUCK
BEACON FALLS
Candlewood Lake
SHEPAUG DAM
HAWLEYVILLE
LAKE ZOAR
DANBURY
Lake Kenosia
STEVENSON DAM
SEYMOUR
ANSONIA
SHELTON
DERBY
NEW HAVEN
W. HAVEN
E. HAVEN
TRUMBULL
DEVON
STRATFORD
BRIDGEPORT
WESTPORT
FAIRFIELD
NORWALK
S. NORWALK
GREENWICH
STAMFORD
SCALE IN MILES
0 4 8 12
WATER RESOURCES DEVELOPMENT PROJECT
HOUSATONIC RIVER BASIN MAP
NEW ENGLAND DIVISION WALTHAM, MASS

PLATE 1

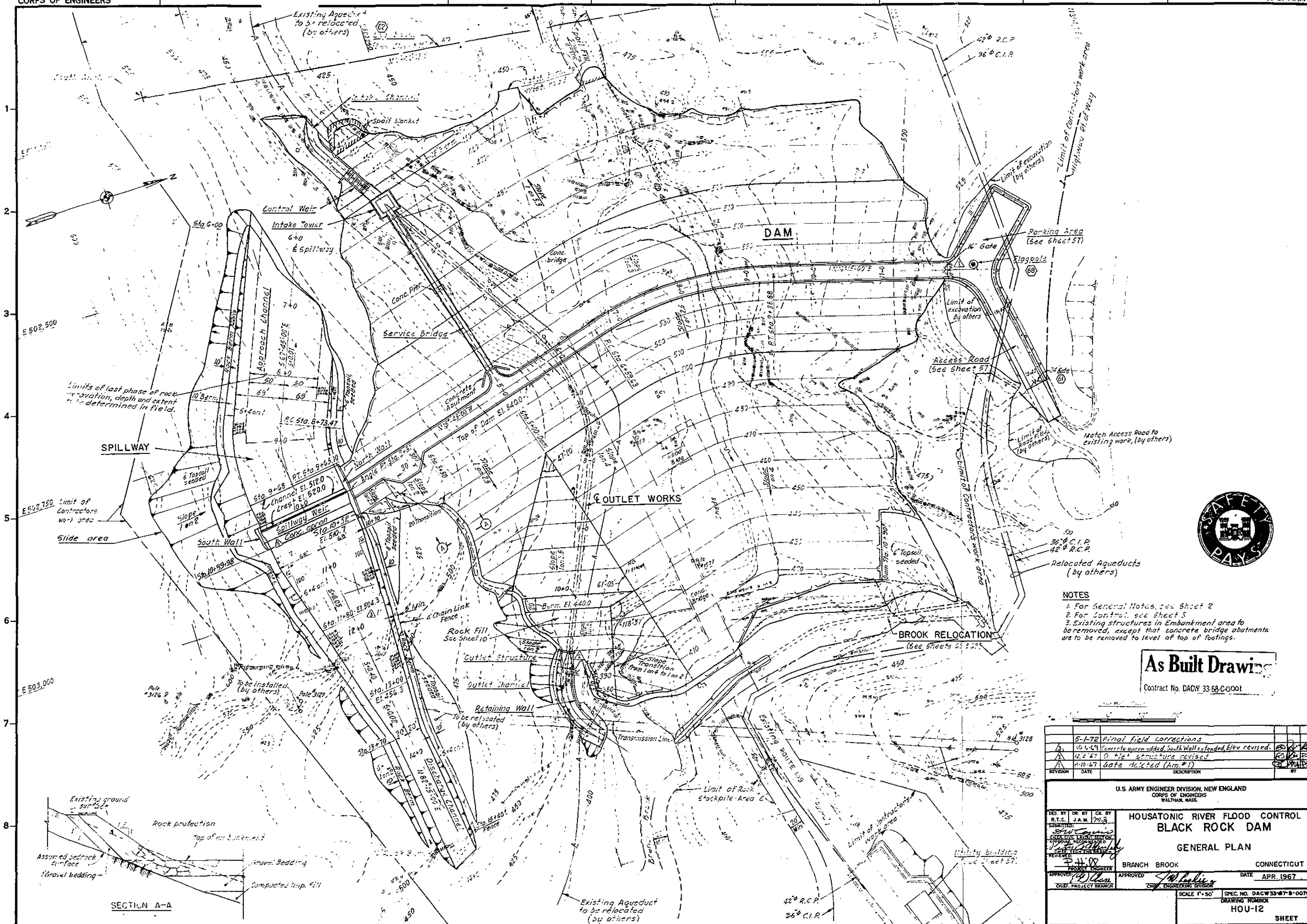

HALL MEADOW BROOK DAM
EAST BRANCH DAM
WEST BRANCH NAUGATUCK RIVER LOCAL PROTECTION
EAST BRANCH AND NAUGATUCK RIVER LOCAL PROTECTION
THOMASTON DAM
NORTHFIELD BROOK DAM
BLACK ROCK DAM
HANCOCK BROOK DAM
WATERBURY & WATERTOWN LOCAL PROTECTION
HOP BROOK DAM
ANSONIA LOCAL PROTECTION
DERBY LOCAL PROTECTION
STEVENSON DAM
WINSTED
GOSHEN RELAY
TORRINGTON
TORRINGFORD
EAST LITCHFIELD
CAMPVILLE
THOMASTON
PLYMOUTH
BRISTOL
WATERTOWN
OAKVILLE
WATERVILLE
WOLCOTT
WATERBURY
CRONOKE
PLATTS MILL
UNION CITY
NAUGATUCK
NAUGATUCK REPEATER
BEACON FALLS
BETHANY
OXFORD
SEYMOUR
ANSONIA
SHELTON
DERBY
HOUSATONIC RIVER
NAUGATUCK RIVER
WEST BRANCH
LEGEND
RECORDING GAGE (RIVER)
NON-RECORDING GAGE (RIVER)
TELEMARK GAGE
RECORDING GAGE (RAINFALL)
NON-RECORDING GAGE (RAINFALL)
SNOW SURVEY COURSE
AUTOMATIC HYDROLOGIC RADIO REPORTING NETWORK RELAY (CONTAINS RADIOS TIED DIRECTLY TO RCC COMPUTER ROOM)
SCALE IN MILES
1 0 1 2
WATER RESOURCES DEVELOPMENT PROJECT
HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED MAP
NEW ENGLAND DIVISION WALTHAM, MASS



BLACK ROCK DAM
(LOOKING DOWNSTREAM)

PLATE 3

CORPS OF ENGINEERS U. S. ARMY



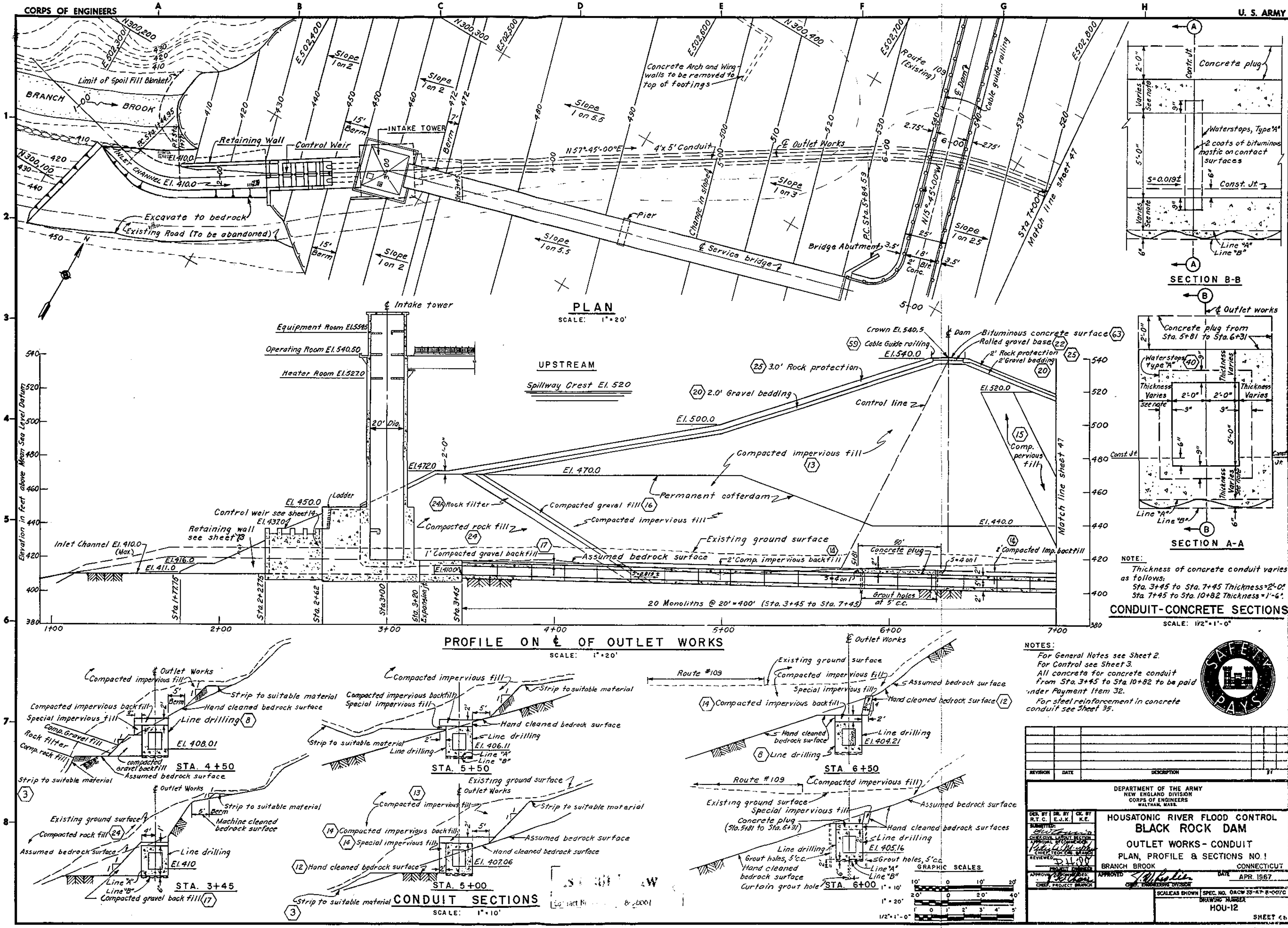

CORPS OF ENGINEERS
U. S. ARMY
PLAN
SCALE: 1" = 20'
BRANCH BROOK
Limit of Spoil Fill Blanket
Retaining Wall
Control Weir
INTAKE TOWER
INLET CHANNEL El. 410.0
Excavate to bedrock
Existing Road (To be abandoned)
N57°-45'-00"E
4'x 5' Conduit
℄ Outlet Works
Concrete Arch and Wing walls to be removed to top of footings
Change in slope
Pier
℄ Service bridge
Bridge Abutment
Route 109 (Existing)
℄ Dam
Cable guide railing
Match line sheet 47
SECTION B-B
Concrete plug
Waterstops, Type "A"
2 coats of bituminous mastic on contact surfaces
Const. Jt.
Line "A"
Line "B"
SECTION A-A
℄ Outlet works
Concrete plug from Sta. 5+81 to Sta. 6+31
Thickness Varies
NOTE:
Thickness of concrete conduit varies as follows:
Sta. 3+45 to Sta. 7+45 Thickness = 2'-0"
Sta. 7+45 to Sta. 10+82 Thickness = 1'-6"
CONDUIT-CONCRETE SECTIONS
SCALE: 1/2" = 1'-0"
℄ Intake tower
Equipment Room El. 559.5
Operating Room El. 540.50
Heater Room El. 527.0
UPSTREAM
Spillway Crest El. 520
Crown El. 540.5
Cable Guide railing
Bituminous concrete surface
Rolled gravel base
2' Rock protection
2' Gravel bedding
3.0' Rock protection
2.0' Gravel bedding
Control line
Compacted impervious fill
Comp. pervious fill
Permanent cofferdam
Rock filter
Compacted gravel fill
Compacted rock fill
Existing ground surface
Assumed bedrock surface
1' Compacted gravel backfill
2' Comp. impervious backfill
Compacted Imp. backfill
Concrete plug
Grout holes at 5' c.c.
20 Monoliths @ 20' = 400' (Sta. 3+45 to Sta. 7+45)
Control weir see sheet 14
Retaining wall see sheet 13
Inlet Channel El. 410.0 (Max)
Elevation in feet above Mean Sea Level Datum
PROFILE ON ℄ OF OUTLET WORKS
SCALE: 1" = 20'
NOTES:
For General Notes see Sheet 2.
For Control see Sheet 3.
All concrete for concrete conduit from Sta. 3+45 to Sta. 10+82 to be paid under Payment Item 32.
For steel reinforcement in concrete conduit see Sheet 35.
STA. 4+50
STA. 5+50
STA. 6+50
STA. 3+45
STA. 5+00
STA. 6+00
Strip to suitable material
Hand cleaned bedrock surface
Machine cleaned bedrock surface
Line drilling
Special impervious fill
Curtain grout hole
Route #109
CONDUIT SECTIONS
SCALE: 1" = 10'
GRAPHIC SCALES
SAFETY PAYS
REVISION | DATE | DESCRIPTION
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
HOUSATONIC RIVER FLOOD CONTROL
BLACK ROCK DAM
OUTLET WORKS - CONDUIT
PLAN, PROFILE & SECTIONS NO. 1
BRANCH BROOK
CONNECTICUT
APR. 1967
HOU-12

PLATE 5

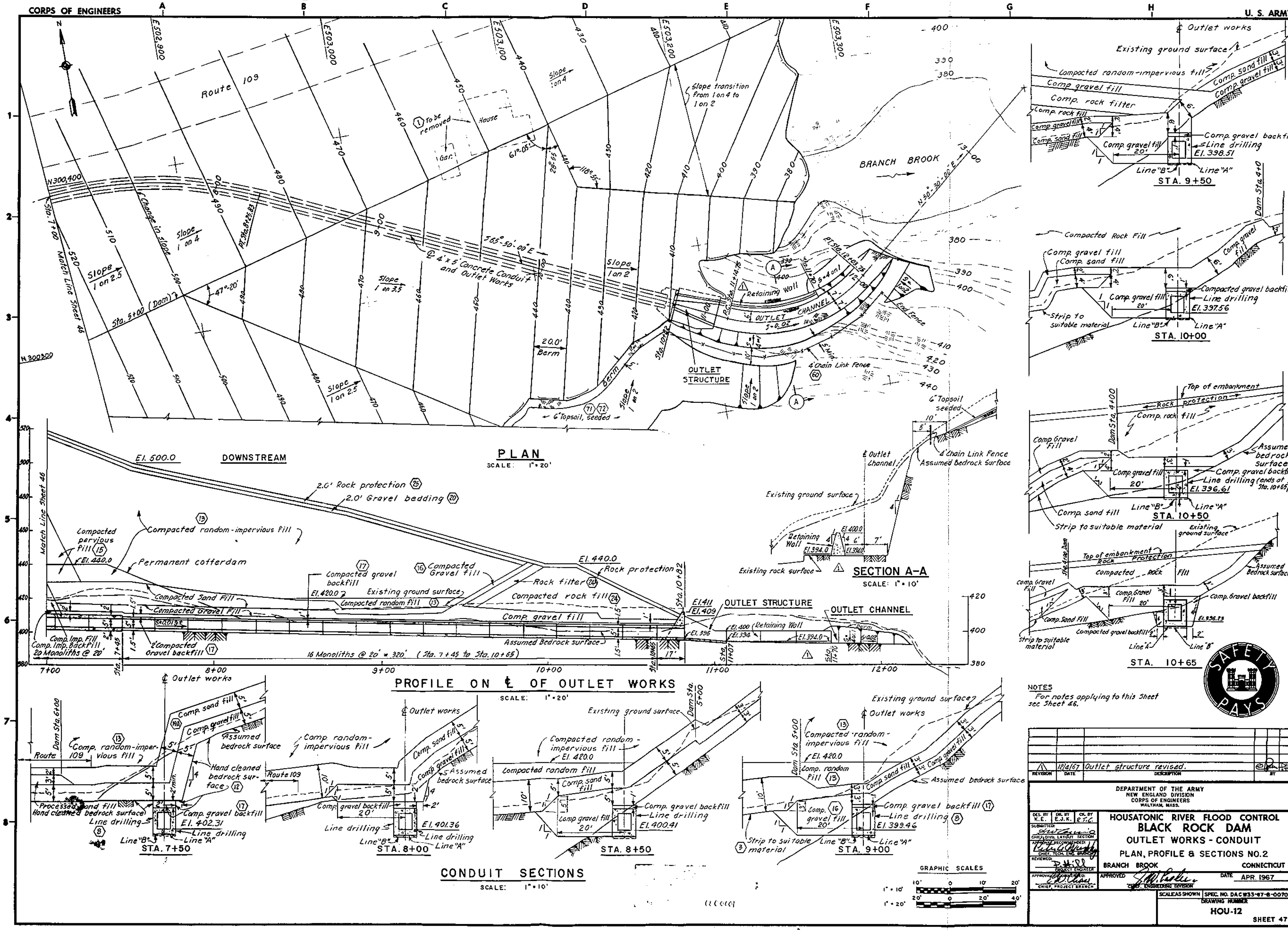
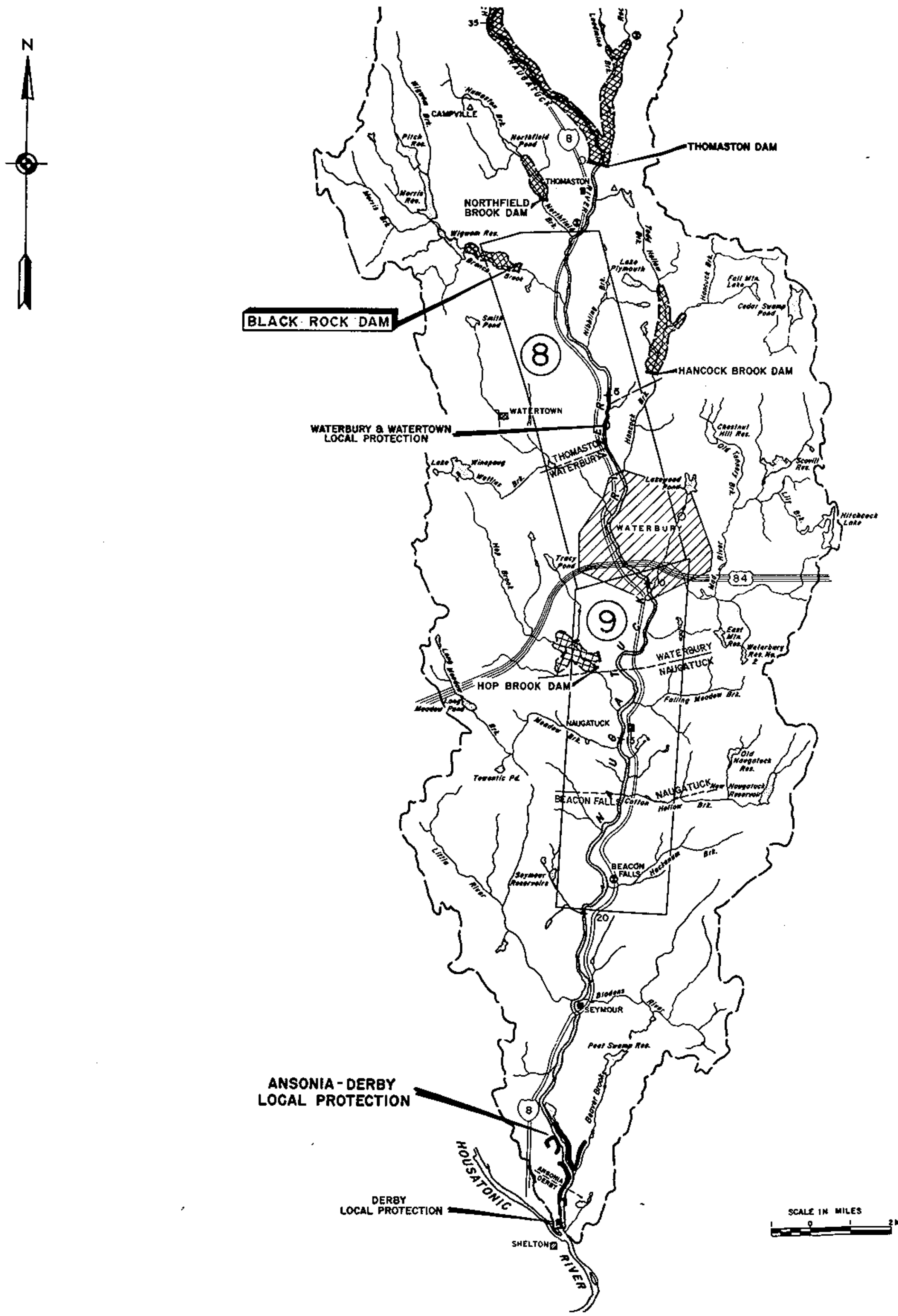

CORPS OF ENGINEERS
U. S. ARMY
A
B
C
D
E
F
G
H
1
2
3
4
5
6
7
8
E 502,900
E 503,000
E 503,100
E 503,200
E 503,300
N
Route 109
① To be removed
House
Gar.
N 300,400
N 300,300
Sta. 7+00
Match Line Sheet 46
Change in slope
Slope 1 on 4
Slope 1 on 2.5
Slope 1 on 3.5
Slope 1 on 2
Sta. 5+00 (Dam)
47°-20'
S 65°-50'-00" E
4'x 5' Concrete Conduit and Outlet Works
Slope transition from 1 on 4 to 1 on 2
20.0' Berm
Berm
6" Topsoil, seeded
OUTLET STRUCTURE
Retaining Wall
OUTLET CHANNEL
End Fence
4' Chain Link Fence
BRANCH BROOK
N 50°-30'-00" E
PLAN
SCALE: 1" = 20'
El. 500.0
DOWNSTREAM
2.0' Rock protection
2.0' Gravel bedding
Compacted pervious fill
El. 440.0
Compacted random-impervious fill
Permanent cofferdam
Compacted gravel backfill
Compacted Gravel fill
Existing ground surface
El. 420.0
Compacted Sand Fill
Compacted random fill
Rock filter
Compacted rock fill
Rock protection
Comp. gravel fill
Assumed Bedrock surface
Comp. Imp. Fill
Comp. Imp. Backfill
20 Monoliths @ 20'
Compacted Gravel backfill
16 Monoliths @ 20' = 320' (Sta. 7+45 to Sta. 10+65)
El. 411
El. 409
OUTLET STRUCTURE
OUTLET CHANNEL
Retaining Wall
El. 394.0
7+00
8+00
9+00
10+00
11+00
12+00
PROFILE ON ℄ OF OUTLET WORKS
SCALE: 1" = 20'
6" Topsoil seeded
℄ Outlet Channel
4' Chain Link Fence
Assumed bedrock surface
Existing ground surface
Retaining Wall
Existing rock surface
SECTION A-A
SCALE: 1" = 10'
℄ Outlet works
Existing ground surface
Compacted random-impervious fill
Comp. sand fill
Comp. gravel fill
Comp. rock filter
Comp. rock fill
Comp. gravel backfill
Line drilling
El. 398.51
Line "B"
Line "A"
STA. 9+50
Compacted Rock Fill
Comp. gravel fill
Comp. sand fill
Compacted gravel backfill
El. 397.56
Strip to suitable material
STA. 10+00
Top of embankment
Rock protection
Comp. rock fill
Comp. Gravel Fill
Assumed bedrock surface
El. 396.61
Line drilling (ends at Sta. 10+65)
Strip to suitable material
STA. 10+50
Compacted Rock Fill
Comp. Sand Fill
Compacted gravel backfill
El. 396.23
STA. 10+65
Comp. random-impervious fill
Route 109
Dam Sta. 6+00
Processed sand fill
Hand cleaned bedrock surface
Hand cleaned bedrock surface
Comp. gravel backfill
El. 402.31
Line drilling
STA. 7+50
Comp. random-impervious fill
Comp. gravel backfill
El. 401.36
STA. 8+00
Compacted random-impervious fill
El. 420.0
Compacted random fill
El. 400.41
STA. 8+50
Compacted random-impervious fill
Comp. random fill
Comp. gravel fill
El. 399.46
Strip to suitable material
STA. 9+00
CONDUIT SECTIONS
SCALE: 1" = 10'
GRAPHIC SCALES
1" = 10'
1" = 20'
NOTES
For notes applying to this Sheet see Sheet 46.
SAFETY PAYS
10/4/67 Outlet structure revised.
REVISION DATE DESCRIPTION BY
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
HOUSATONIC RIVER FLOOD CONTROL
BLACK ROCK DAM
OUTLET WORKS - CONDUIT
PLAN, PROFILE & SECTIONS NO. 2
BRANCH BROOK
CONNECTICUT
DATE APR. 1967
SCALE AS SHOWN
SPEC. NO. DACW33-67-B-0070
DRAWING NUMBER
HOU-12
SHEET 47

PLATE 6



CROSS SECTION DATA						
				DAM BREACH FLOOD		
PLATE NO.	SECTION NO.	RIVER MILE	DIST. D/S FROM DAM (MI.)	ARRIVAL † TIME (HOURS)	PEAK TIME †(HOURS)	PEAK EL. (FT.-NGVD)
8	1.70	1.70	1.70	0.2	1.0	377.8
8	2.50	2.50	2.50	0.6	1.2	346.6
8	6.38	6.38	6.38	1.2	1.7	303.4
8	9.36	9.36	9.36	1.7	2.5	284.2
9	14.45	14.45	14.45	2.6	3.5	208.9
9	18.77	18.77	18.77	3.2	4.3	139.3

† FROM START OF BREACH FORMATION

INUNDATION MAP PLATE (8) — LOCATION OF MAP PANELS

+ 10 RIVER MILES DOWNSTREAM FROM BLACK ROCK DAM

LEGEND

- U.S. GEOLOGICAL SURVEY GAGING STATION
- CITIES
- FLOOD CONTROL DAM SITES

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED

BLACK ROCK DAM BREACH FLOOD
INDEX MAP

NAUGATUCK RIVER CONNECTICUT

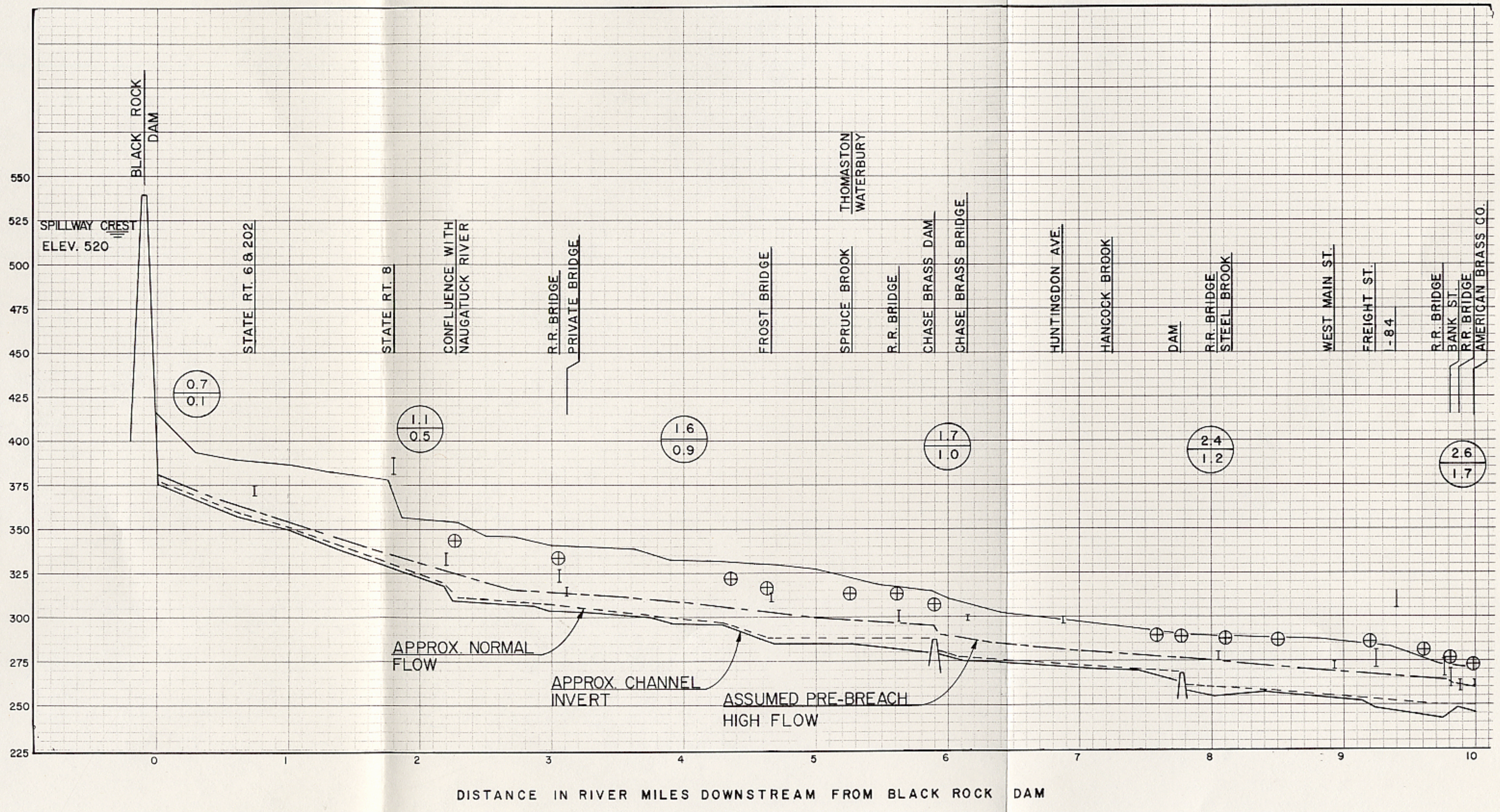
HYDRO. ENGR. SECT. SEPTEMBER 1983

PLAN

SCALE: 1" = 2000'

0 2000 4000

FEET



LEGEND

⊕ EXPERIENCED AUGUST 1955 FLOOD ELEVATIONS.

(1.7 / 1.0) HOURS FROM START OF FAILURE. HOURS TO INITIAL RIVER RISE.

LIMITS OF BREACH FLOOD

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED

BLACK ROCK DAM BREACH FLOOD

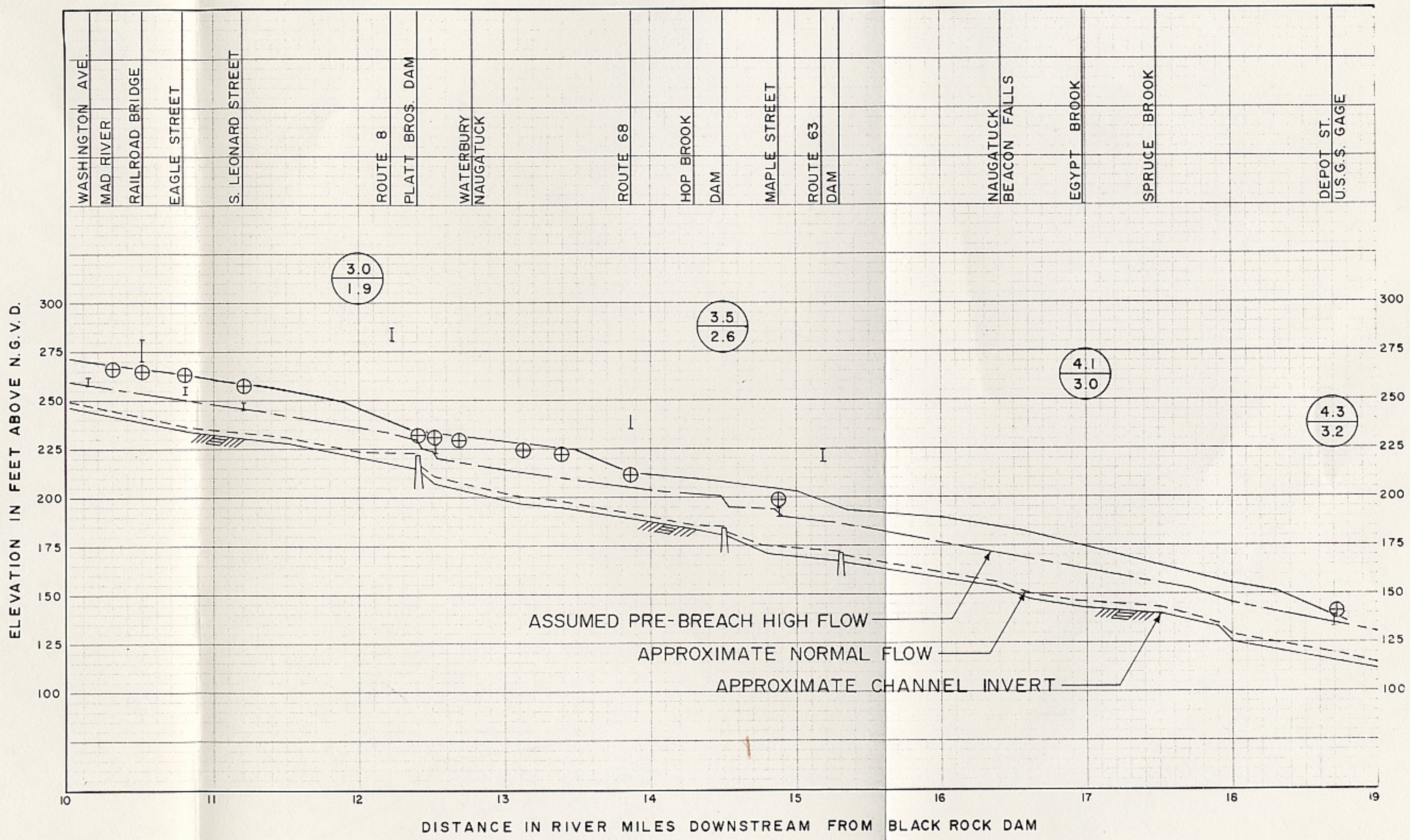
PLAN & PROFILE #1

HYDRO. ENG. SECT. SEPTEMBER 1983

PLAN

SCALE: 1" = 2000'

0 2000 4000
FEET



LEGEND

⊕ EXPERIENCED AUGUST 1955 FLOOD ELEVATIONS

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

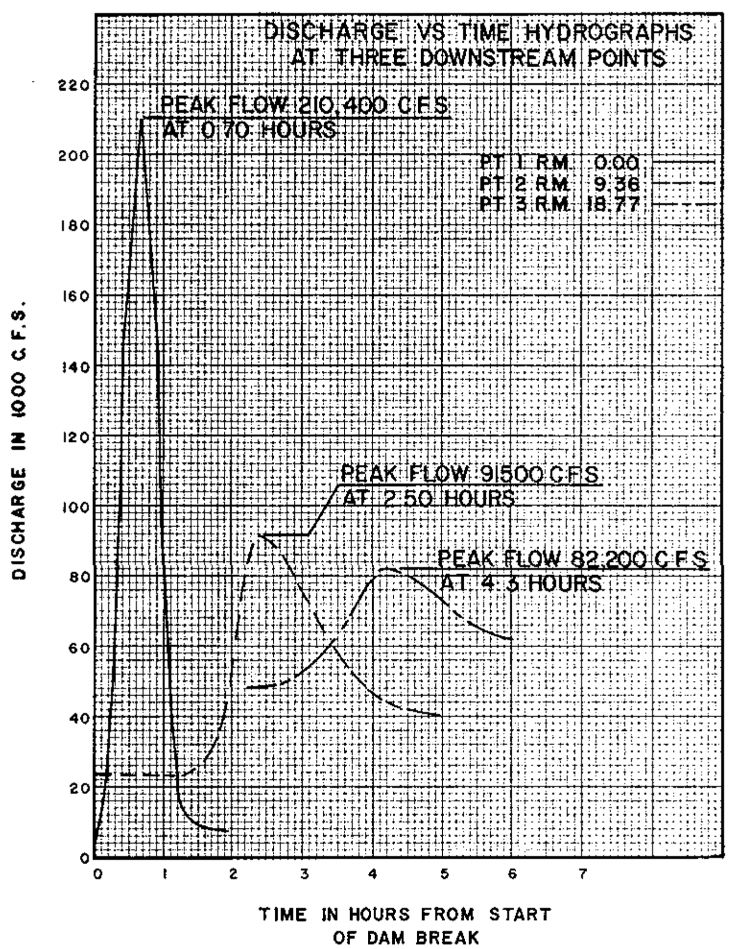
HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED
BLACK ROCK DAM BREACH FLOOD

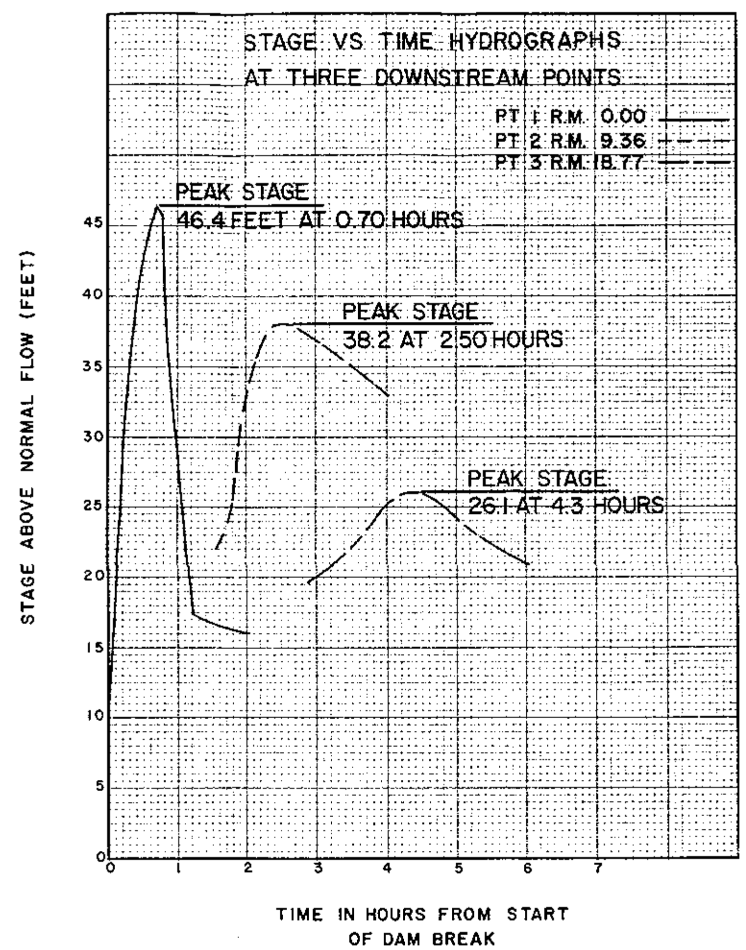
PLAN & PROFILE #2

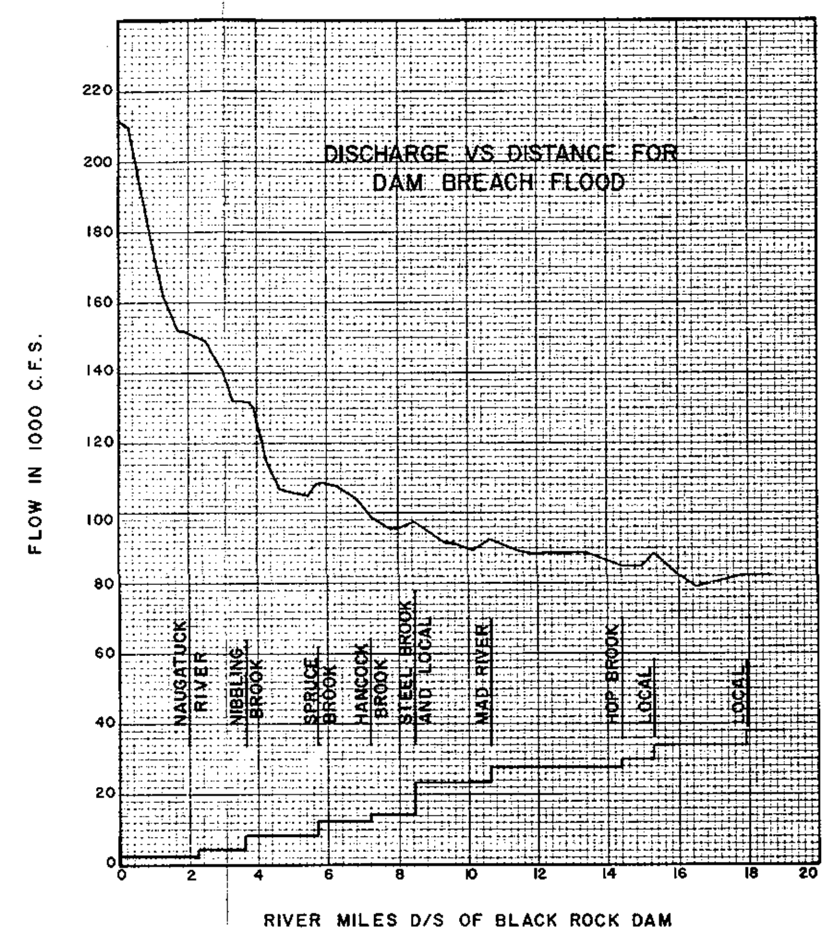
HYDRO. ENG. SECT. SEPTEMBER 1983

PLATE 9

CORPS OF ENGINEERS   A   B   C   D   E   F   G   H   U. S. ARMY







DEPARTMENT OF THE ARMY
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WALTHAM, MASS.

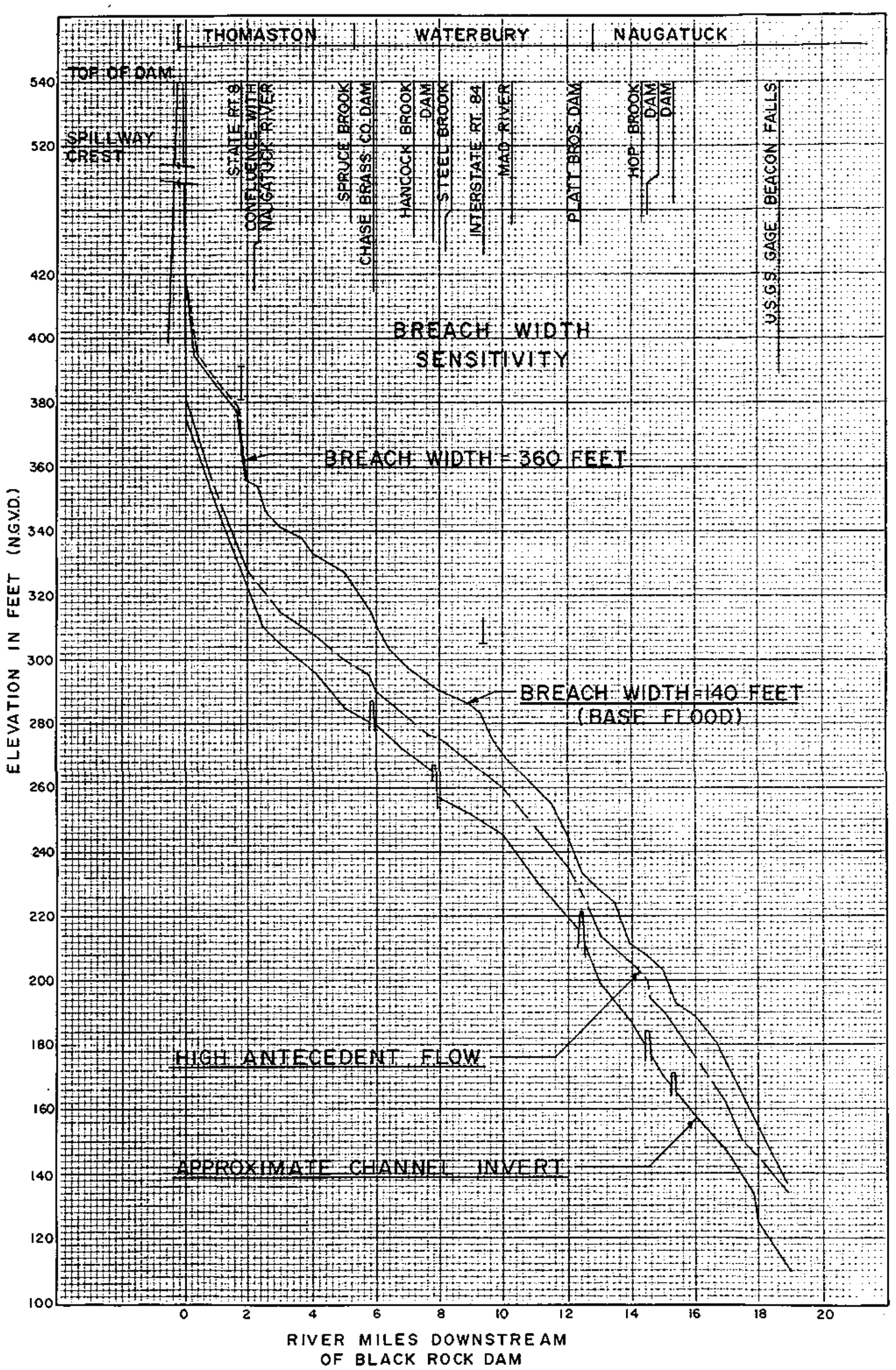
HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED

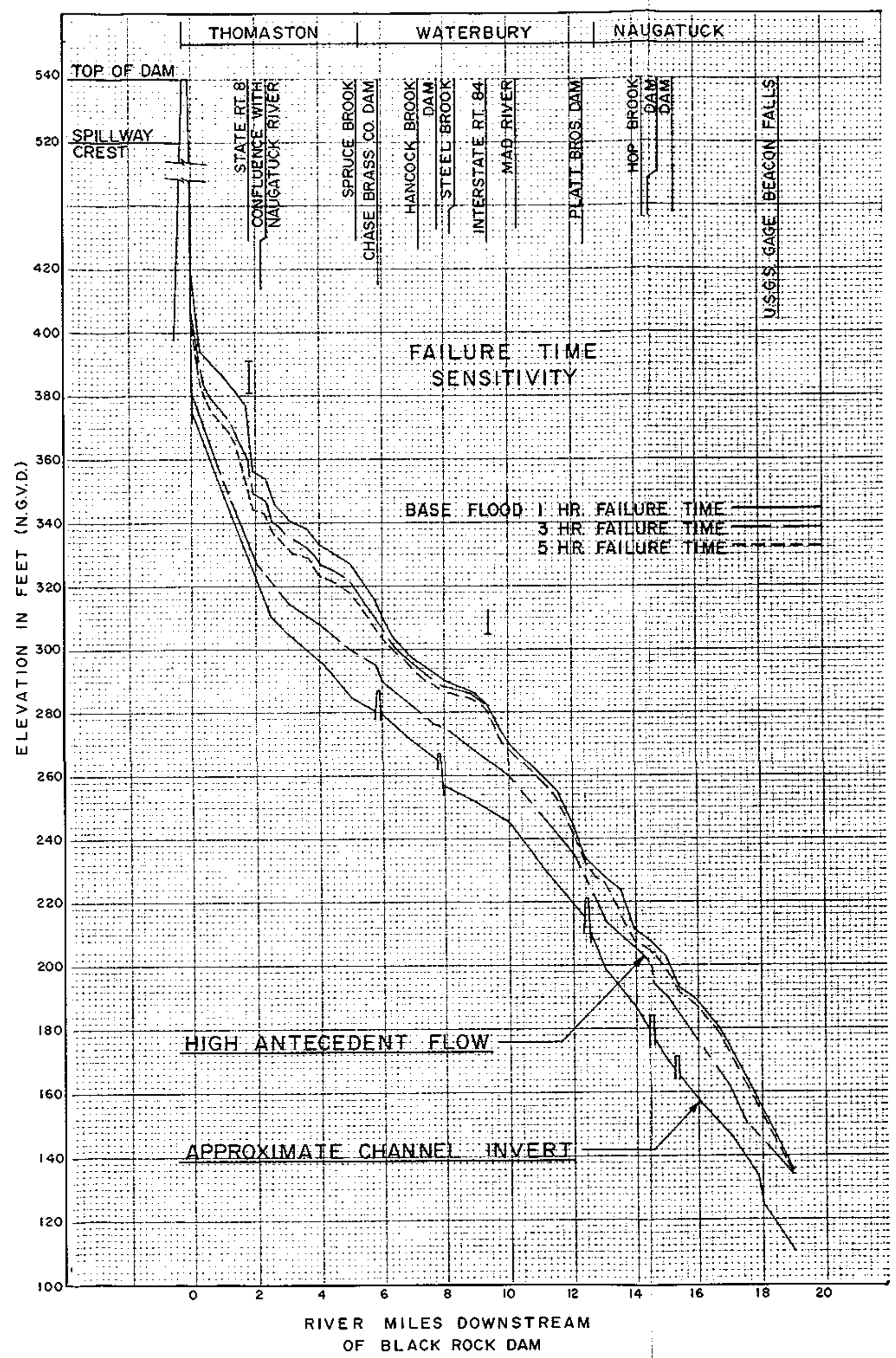
BLACK ROCK DAM FAILURE FLOOD

FLOOD DISCHARGES, STAGES AND TIMING

HYDRO. ENG. SECT.   SEPTEMBER 1983

PLATE 10





DEPARTMENT OF THE ARMY
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WALTHAM, MASS.

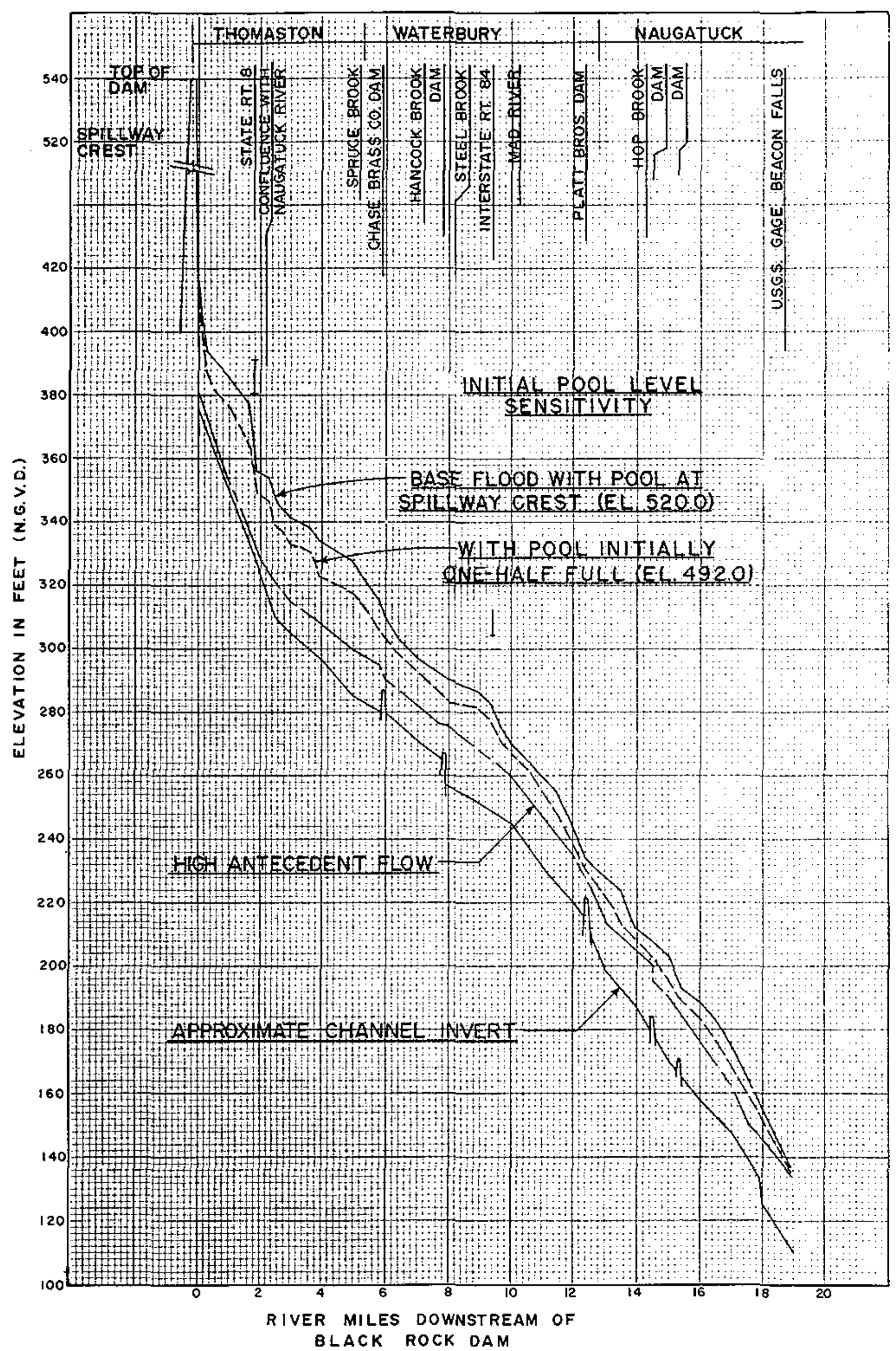
HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED

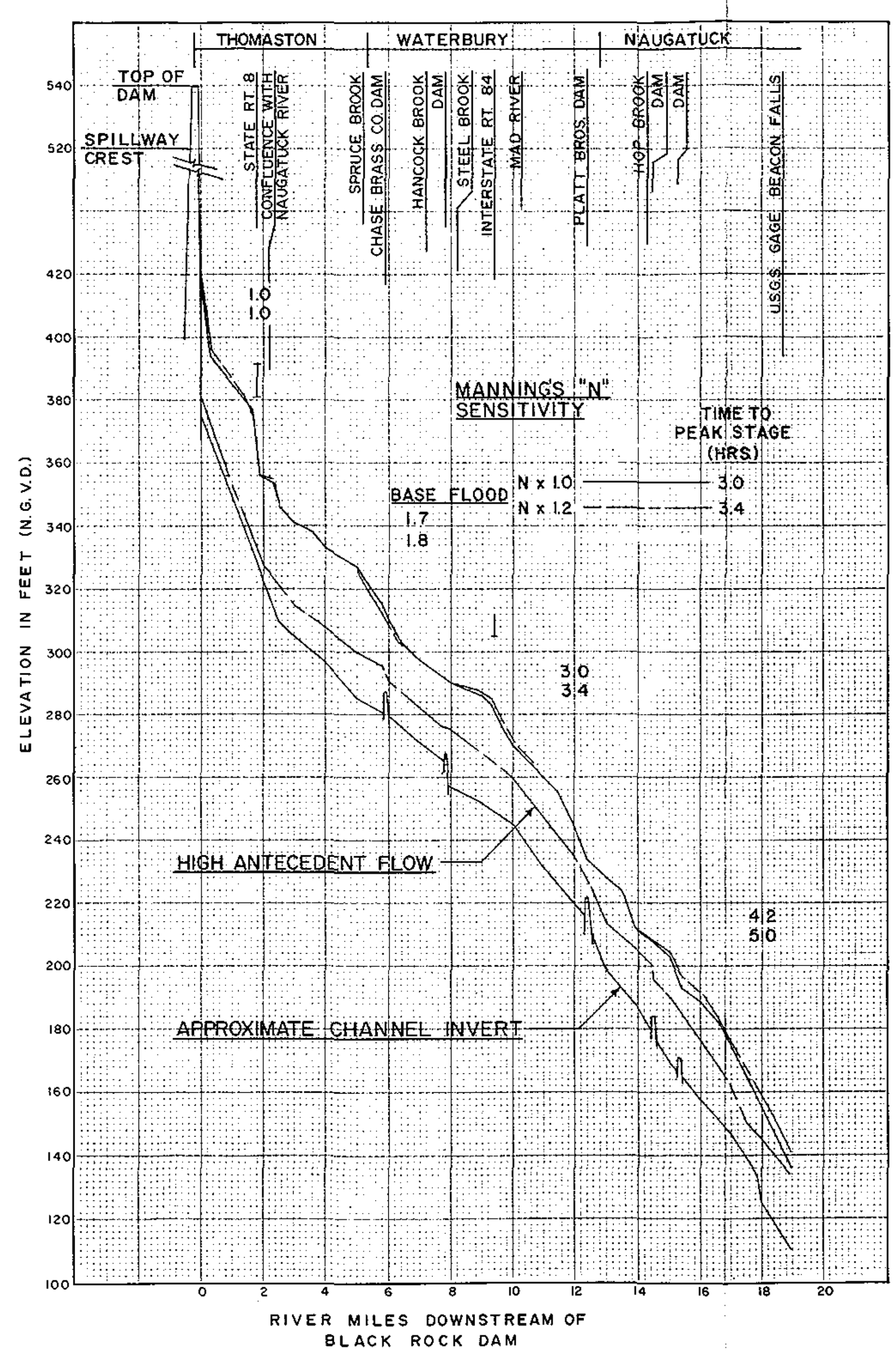
BLACK ROCK DAM BREACH FLOOD

SENSITIVITY OF INPUT PARAMETERS NO. 1

HYDRO. ENG. SECT. SEPTEMBER 1983

PLATE 11





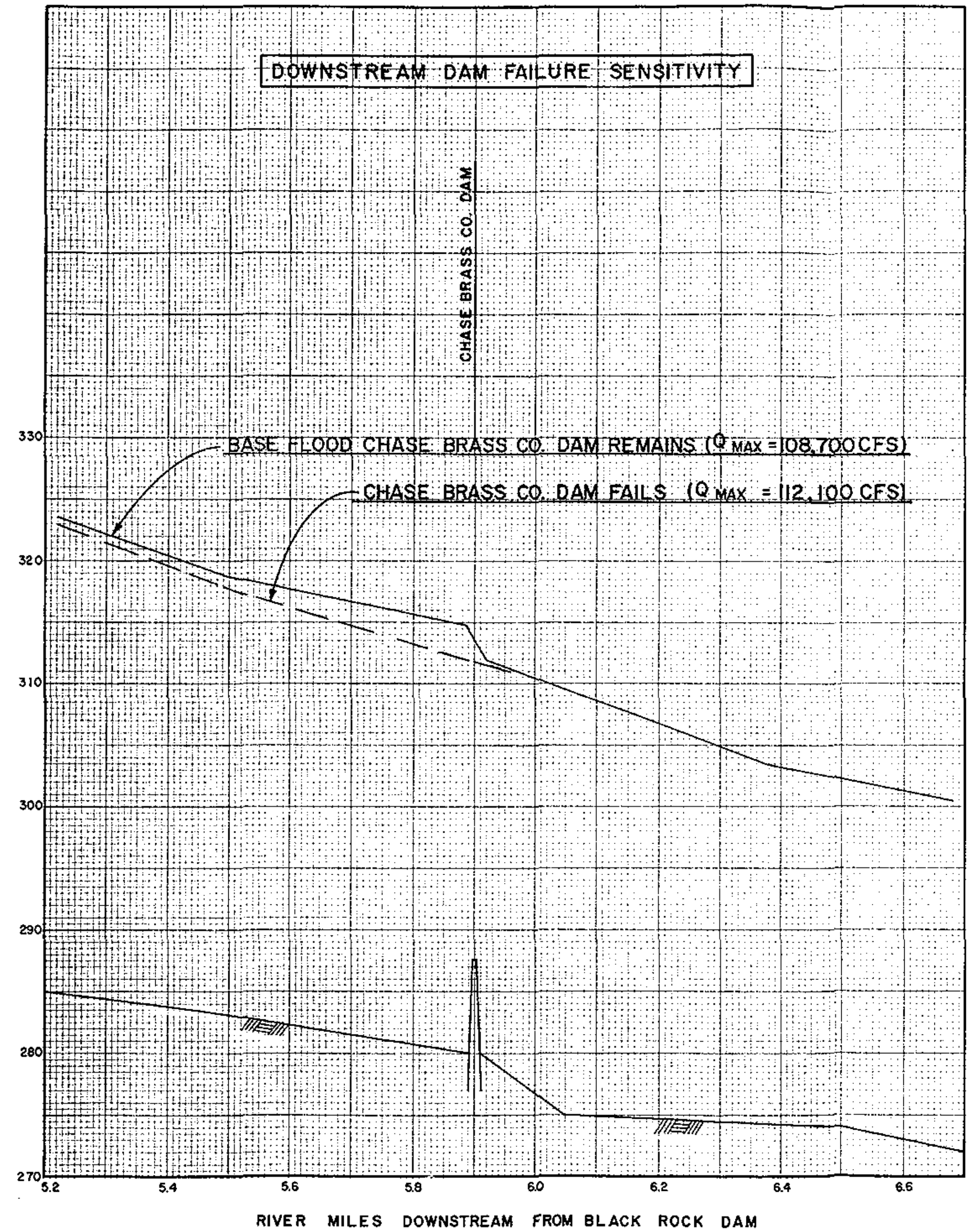
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

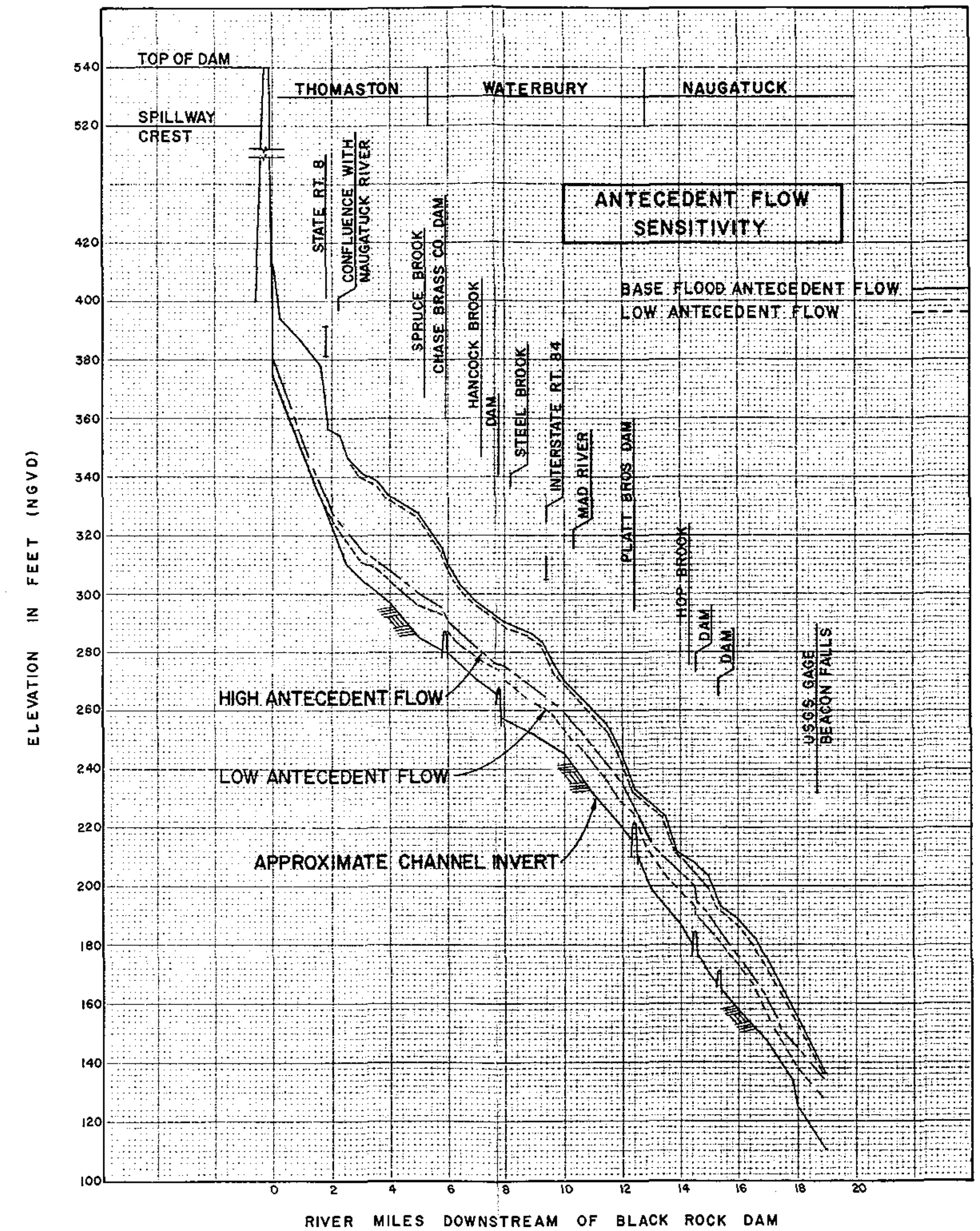
HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED
BLACK ROCK DAM FAILURE FLOOD

SENSITIVITY OF INPUT PARAMETERS NO. 2

HYDRO. ENG. SECT. SEPTEMBER 1983

PLATE 12





DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

HOUSATONIC RIVER BASIN
NAUGATUCK RIVER WATERSHED

BLACK ROCK DAM BREACH FLOOD
SENSITIVITY OF INPUT PARAMETERS NO. 3

HYDRO. ENG. SECT. SEPTEMBER 1983

PLATE 13

```
LI BLRK2N8
===> LI BLRK2N8
*HECFORMAT
*FREEFORMATTED
ID,BLACK ROCK DAM
ID,NAUGATUCK RIVER
ID,MARK GEIR NED
ID,424 TRAPELO RD 115N
ID,WALTHAM MASS
IO,9,8,
IP,3,0
QI,9200,7800,5900,5500,5500
QT,0,2,4,6,8
SN, BLACK ROCK LAKE
SE,525,510,500,490,480,470,450,400
SA,200,168,147,126,106,83,40,0
DN, BLACK ROCK DAM
DD,540,520,0,520,50,.07,400
DR,1,520,140,400,2
DO,2500,518,0,2612
DN,STATE RT 8 EMBANKMENT
DD,391,327,0,0,20,.05
DR,1,500,200,327,2,
DO,0,420,0,3480
DN,  CHASE BRASS CO DAM
DD,296,287.7,,,8,.06
DR,1,300,200,280,2,
DO,0,576,0,330
DN,  DAM U/S STEEL BRK
DD,280,268,0.0,,2,.04
DR,1,500,100,,2,5
DO,0,640,0,840
DN,  PLATT BROS DAM
DD,228,221.3,0,,15,.04
DR,1,500,100,,2,5
DO,0,1812,0,150
DN,  DAM D/S OF HOP BRK
DD,210,184.4,,,16,.04
DR,1,500,100,180,.5,1
DO,0,704,0,1000,
RN,REACH 1 BLACK ROCK DAM TO STATE RT 8
RP,4,,1
RG,1
RC,330.29
XI,0,0,,,,,25
XE,370,371,380,381,390,410,450,500
XC,0,20,50,55,100,210,400,700
XO
NC,.08,.085,.085,.09,.09,.095,.0955,.10
XI,.58,.58
XE,359,360,370,371,380,400,401,450
XC,40,50,980,1240,1800,2480,2750,3270
XO,0,0,0,0,0,400,650,300
NC,.08,.085,.085,.09,.09,.095,.0955,.10
XI,1.02,1.02
XE,349,350,360,380,390,391,400,450
XC,60,90,940,1080,1190,1800,1900,2300
XO,0,0,0,0,0,600,600,400
NC,.08,.085,.085,.09,.09,.095,.0955,.1
XI,1.31,1.31
```

```
XE,340,341,350,360,370,380,390,450
XC,40,60,220,430,540,640,1020,1800
XO
NC,.08,.085,.085,.09,.09,.095,.0955,.10
XI,1.7,1.7,0,0,0,0,0,.3
XE,315,331,340,341,350,380,400,450
XC,20,40,80,480,560,1000,1300,1800
XO
NC,.08,.085,.085,.09,.095,.0955,.0955,.100
RN,REACH 2 RT 8 TO CHASE BRASS CO DAM
RP,4,,1
RG,3
RG,295.5
XI,1.86,1.86
QN,1.86,,          FLOW FROM MAIN STEM NAUGATUCK
QL,2000,2000,2000,2000
XE,323,330,331,340,350,380,400,450
XC,0,50,960,1480,1650,1820,1930,2300
XO
NC,.03,.03,.04,.045,.05,.055,.06,.07
XI,2.29,2.29
XE,315,320,325,330,340,360,400,450
XC,140,140,140,140,610,900,900,900
XO
NC,.06,.06,.065,.07,.075,.08,.085,.09
XI,2.5,2.5
XE,314,320,325,330,340,360,400,450
XC,220,220,240,330,510,700,880,1100
XO
NC,.06,.06,.065,.07,.075,.08,.085,.09
XI,2.71,2.71
XE,312,315,320,330,350,380,400,450
XC,150,150,150,1190,1350,1500,1600,1850
XO
NC,.06,.06,.065,.07,.075,.08,.085,.09
XI,3.01,3.01
XE,304,315,320,325,340,350,400,450
XC,190,200,300,320,450,500,700,900
XO
NC,.06,.06,.065,.07,.075,.08,.085,.09
XI,3.33,3.33
QN,3.33,,          FLOW FROM NIBBLING BRK
QL,4000,4000,4000,4000,4000,4000
XE,303,315,320,321,350,380,390,400
XC,410,420,620,1380,2140,2350,2480,2620
XO
NC,.06,.06,.065,.07,.075,.08,.085,.09
XI,3.64,3.64
XE,301,315,320,330,340,350,380,400
XC,270,270,450,660,730,810,1100,1300
XO
NC,.06,.06,.065,.07,.075,.08,.085,.09
XI,3.77,3.77
XE,300,310,315,320,340,350,380,400
XC,130,130,240,410,520,580,740,850
XO
NC,.06,.06,.065,.07,.075,.08,.085,.09
XI,3.94,3.94
XE,298,305,310,320,340,360,361,400
XC,140,140,240,530,600,790,900,1100
```

```
XO
NC,.06,.06,.065,.07,.075,.08,.085,.09
XI,4.18,4.18
XE,297,305,310,330,350,370,371,400
XC,375,380,1050,1360,1570,1670,1850,2000
XO
NC,.06,.06,.065,.07,.075,.08,.085,.09
XI,4.34,4.34
XE,296,300,310,311,330,331,350,400
XC,110,110,170,950,1100,1170,1310,1500
XO
NC,.06,.06,.065,.07,.075,.08,.085,.09
XI,4.72,4.72
XE,285,290,295,300,310,350,351,370
XC,0,140,150,230,580,880,1250,1400
XO
NC,.06,.06,.065,.07,.075,.08,.085,.09
XI,5.02,5.02
XE,285,290,300,310,350,370,380,400
XC,0,230,230,370,540,620,770,960
XO
NC,.06,.06,.065,.07,.075,.08,.085,.09
XI,5.49,5.49
QN,5.49,,          FLOW FROM SPRUC BRK
QL,4000,4000,4000,4000,4000,4000
XE,283,288,300,301,350,370,380,400
XC,0,180,190,290,440,530,570,650
XO
NC,.03,.03,.04,.045,.05,.055,.06,.07
XI,5.78,5.78
XE,280,288,300,301,310,320,350,400
XC,0,190,190,370,370,370,370,370
XO
NC,.03,.03,.04,.045,.05,.055,.06,.07
RN,  REACH 3 CHASE BRASS DAM U/S OF STEEL BRK
RP,4
RG,2
RC,276.22
XI,5.95,5.95
XE,279,283,292,293.5,300,330,350,400
XC,0,100,105,190,270,270,270,270
XO
NC,.03,.03,.04,.045,.05,.055,.06,.07
XI,6.38,6.38
XE,275,285,292,293,300,330,350,400
XC,140,140,180,1170,1340,1530,1650,2100
XO
NC,.03,.03,.04,.045,.05,.055,.06,.07
XI,6.88,6.88
XE,272,290,291,310,311,320,321,350
XC,150,150,1380,1510,2350,2550,2700,3150
XO
NC,.03,.03,.04,.045,.05,.055,.06,.07
XI,7.29,7.29
QN,7.29,,          INFLOW FROM HANCOCK BRK
QL,2000,2000,2000,2000,2000,2000
XE,270,276,280,286,287,300,301,350
XC,160,240,480,520,1160,1460,1720,2450
XO
NC,.03,.03,.04,.045,.05,.055,.06,.07
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```
XI,7.78,7.78
QN,7.78,,            LOCAL INFLOW
QL,2000,2000,2000,2000,2000
XE,268,276,280,281,290,291,300,350
XC,350,350,370,850,1100,3320,5120,5950
XO
NC,.03,.03,.04,.045,.05,.055,.06,.07
RN,  DAM U/S STEEL BRK TO PLATT BROS DAM
RP,4
RG,4
RG,227,44
XI,8.01,8.01
QN,8.01,,INFLOW FROM STEEL BRK AND LOCAL
QL,9000,9000,9000,9000,9000
XE,250,260,268,270,276,280,290,300
XC,0,190,190,1120,1150,1210,1530,1830
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,8.48,8.48
XE,250,257,262,270,276,280,290,300
XC,0,150,150,620,960,1200,1520,1600
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,8.84,8.84
XE,250,254,268,272,280,281,290,300
XC,0,170,170,490,1290,1480,1640,1830
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,9.36,9.36
XE,246,251,272,276,280,282,290,300
XC,180,180,190,240,1450,1550,1970,2470
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,9.73,9.73
XE,248,260,270,275,276,290,295,300
XC,110,110,440,490,2070,2480,2590,2720
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,10.19,10.19
QN,10.19,,INFLOW FROM MAD RIVER
QL,4000,4000,4000,4000,4000
XE,244,260,261,264,270,280,290,300
XC,240,240,1260,1290,1690,1920,2330,2610
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,10.63,10.63
XE,235,244,252,256,260,280,290,300
XC,170,170,170,550,1140,1210,1250,1290
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,11.53,11.53
XE,228,240,244,250,260,280,290,300
XC,240,240,410,850,900,1000,1240,1430
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
XI,11.93,11.93
XE,221,232,240,250,252,260,270,300
XC,190,190,260,460,480,740,920,1180
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
```

```
XI,12.41,12.41
XE,210,220,230,240,250,260,270,300
XC,0,240,270,370,570,675,780,1100
XO
NC,.04,.04,.04,.045,.05,.055,.06,.07
RN,  REACH D/S OF PLATT BROS DAM
RP,4
RG,5
RC,196.6
XI,12.73,12.73
XE,200,223,230,234,235,240,250,280
XC,240,240,740,760,1700,1740,1820,2150
XO
NC,.03,.03,.04,.045,.05,.055,.06,.07
XI,12.86,12.86
XE,198,210,220,230,240,250,260,280
XC,190,190,350,530,600,750,900,1300
XO
NC,.06,.06,.06,.06,.065,.065,.065,.07
XI,13.50,13.50
XE,194,197,200,205,210,217,220,224
XC,0,320,320,320,320,320,480,500
XO
NC,.06,.06,.06,.06,.065,.065,.065,.07
XI,13.88,13.88
QN,13.88,,LOCAL INFLOW FROM HOP BRK
QL,2500,2500,2500,2500,2500
XE,184,190,200,208,209,210,215,220
XC,220,220,220,220,1850,2100,2400,2600
XO
NC,.03,.03,.03,.03,.03,.04,.04,.05
XI,14.45,14.45
XE,184,188,195,198,200,201,204,220
XC,420,420,420,420,530,1020,1060,1400
XO
NC,.06,.06,.065,.07,.075,.08,.085,.09
RN,, REACH D/S OF DAM D/S OF HOP BROOK
RP,4
RG,7
RC,0
XI,15.02,15.02
QN,15.02,,LOCAL INFLOW FROM LONGMEADOW BRK
QL,4000,4000,4000,4000,4000
XE,168,170,180,184,190,200,201,210
XC,200,200,200,200,400,550,2400,2550
XO
NC,.03,.03,.035,.04,.06,.065,.07,.08
XI,15.36,15.36
XE,166,172,180,184,190,195,200,210
XC,0,300,300,310,550,730,900,1000
XO
NC,.03,.03,.035,.04,.045,.05,.055,.06
XI,16.08,16.08
XE,155,161,165,170,175,180,185,190
XC,120,120,120,120,600,1060,1400,1750
XO
NC,.03,.03,.035,.04,.045,.05,.055,.06
XI,16.57,16.57
QN,16.57,,LOCAL INFLOW
QL,4000,4000,4000,4000,4000
```

```
XE,150,156,160,165,170,175,180,190
XC,0,150,150,200,240,290,330,420
XO
NC,.06,.06,.065,.07,.07,.07,.075,.075
XI,17.97,17.97
XE,125,136,145,150,155,160,170,180
XC,300,300,300,300,450,600,660,700
XO
NC,.03,.03,.035,.04,.045,.05,.055,.06
XI,18.30,18.30
XE,120,128,135,140,145,150,155,160
XC,100,100,100,100,600,1000,1300,1600
XO
NC,.03,.03,.03,.04,.045,.05,.055,.06
XI,18.77,18.77
XE,114,119,125,130,135,140,150,160
XC,180,180,180,250,400,550,680,720
XO
ZZ
$EOF
EOF..
EOT..
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